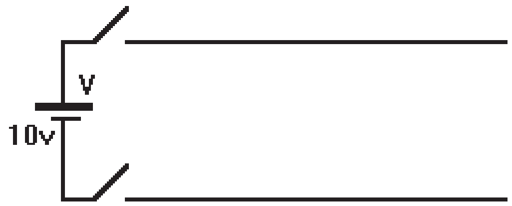
The Third Catt Question.

A battery is connected to two parallel plates, or to a coaxial cable.



Close the switches.

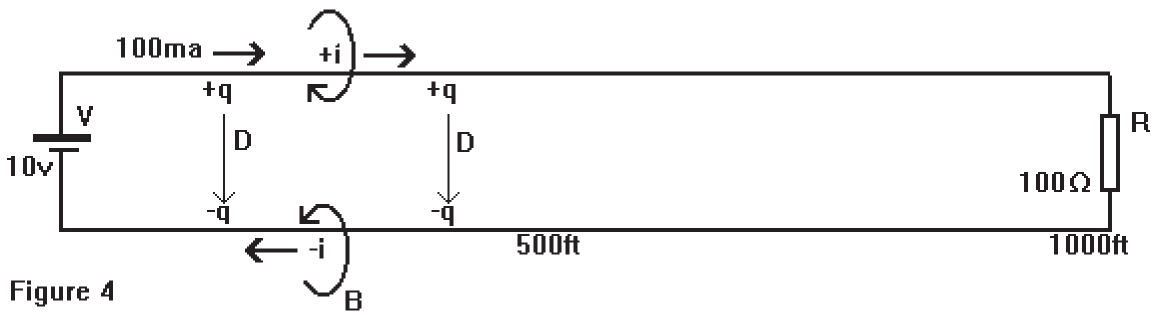
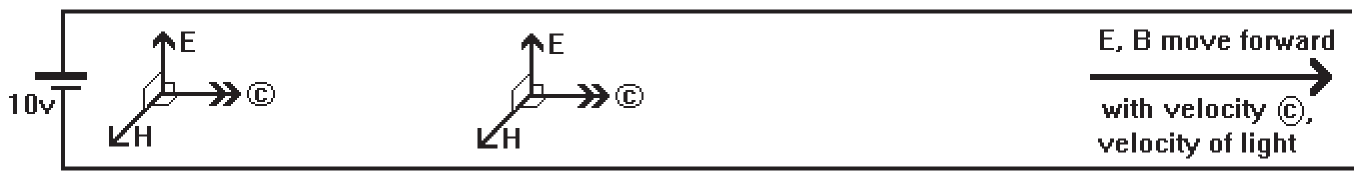
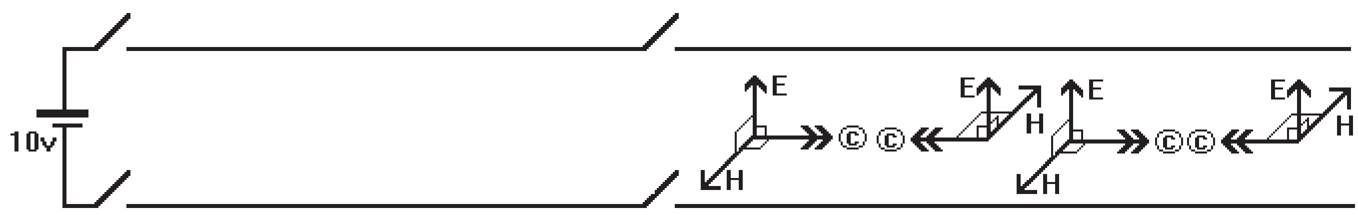


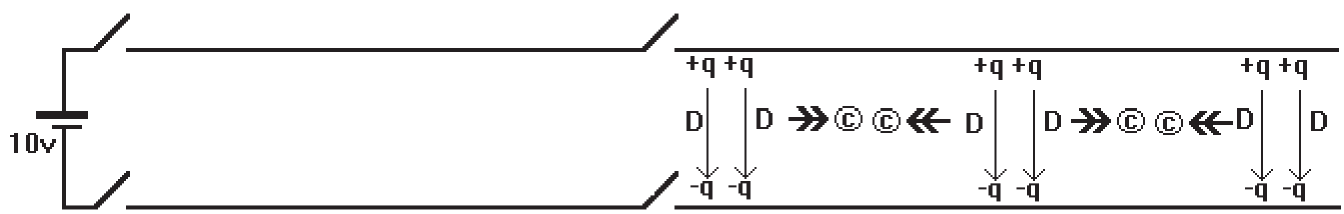
Figure 4



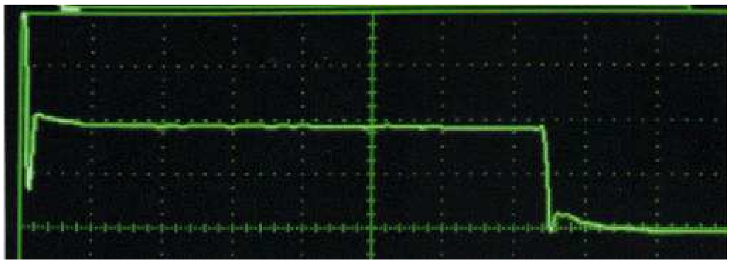
When the energy has reached the right hand end, open the two switches by the battery. The energy reflects towards the left.

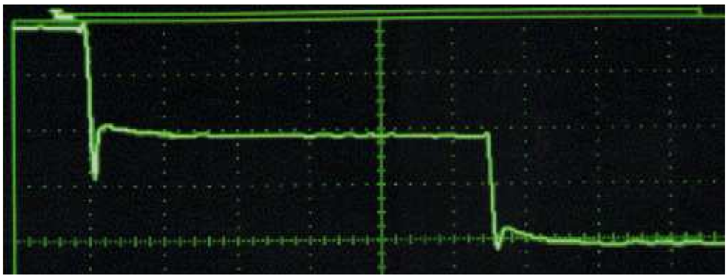
At this point, below, open the two switches in the middle. Is the right hand section a charged capacitor?

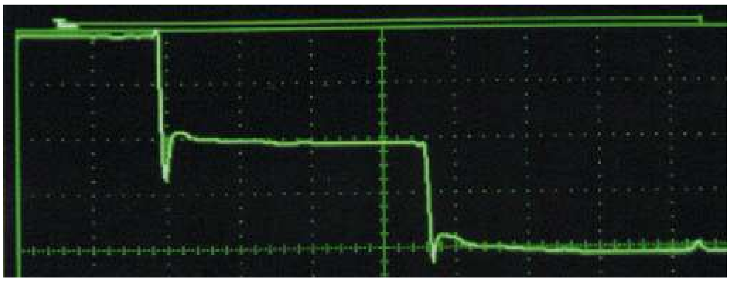


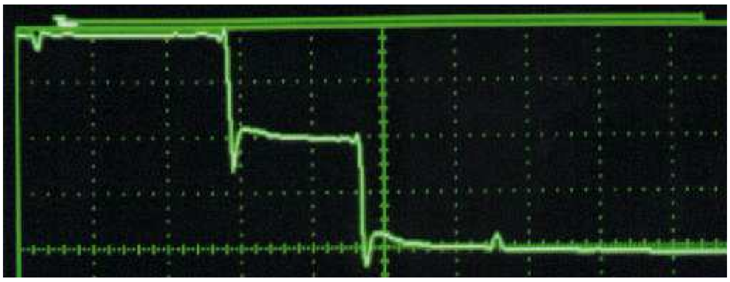


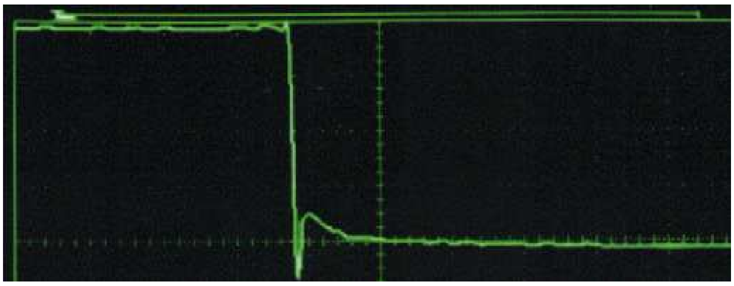
Discussion of the oscilloscope pictures in http://www.ivorcatt.co.uk/x34.pdf


At the right hand end.


25% towards the left.


50% towards the left.


75% towards the left.


At the left.

The five oscilloscope monitor points in the charged cable. At the right, 25% towards the left, 50% towards the left, 75% towards the left, and lastly at the left.

The left hand end of the pictures is at the moment when the switch closes and energy begins to exit.

The first picture is at the right hand end. Immediately, the energy which should have reflected and started off towards the left is no longer in the cable, since it has exited. So the voltage drops from 8 volts – the rightwards travelling energy plus the leftwards – down to 4v, now only the rightwards travelling energy.

In the second picture, 25% towards the left, there is initially no knowledge that anything has happened, so the voltage remains at 8v. However, after a short while (one square), the back end of the energy still travelling to the left passes, and the voltage drops from 8v to 4v. This drop occurs later at 50% and 75%, as the back end of the leftward travelling energy passes. In the final picture, the back end of the leftwards travelling energy finally arrives and reflects, so that there is a sudden drop from 8v to 0v because both leftwards and rightwards energy disappear at the same moment.

Ivor Catt. 14 January 2013

Let us return to the first picture. We see a pulse nearly 8 squares long. On the left is the energy which exits first. The furthest to the right is the energy which exits last. This last was the energy which had just reflected at the right, and was travelling to the left when the switch closed. It went all the way to the left hand end, reflected, and returned to the right before exiting. There was a delay of twice the travel time from end to end before it exited to the right.

The key discrediting of classical theory, which says that the electric field was static until the switch closed, is to consider this last portion of energy. At the moment when the switch closed, so providing a new, extra path for energy, the energy which had just reflected at the right hand end rushed away from the new path, delaying twice the travel time from end to end before it finally exited. It would be very difficult to devise a behaviour compatible with classical theory to explain such a long delay. Classical theory asserts that before the switch closes all is stationary. Then at the instant when the switch closes, all the energy at every point in the capacitor suddenly leaps into life, travelling one way and the other at the speed of light. Possibly this indicates instantaneous action at a distance. I cannot see how a stationary field before the switch closes can create the above sequence of five pictures after the switch closes.

If this charged capacitor does not contain a stationary electric field, as the Wakefield experiment proves, then no capacitor contains a stationary electric field.

Now consider a capacitor made up of concentric spheres. As we increase the diameter of the outer sphere to infinity, the capacitance does not drop to zero. If the diameter of the remaining sphere is 1cm, its capacitance works out to be 1pF. Now we see that energy is rotating around the sphere in all directions, most of it concentrated near the sphere, but extending to infinity. It is not clear how we fully develop the particle, for instance the electron, in this way.

Ivor Catt. February 2013

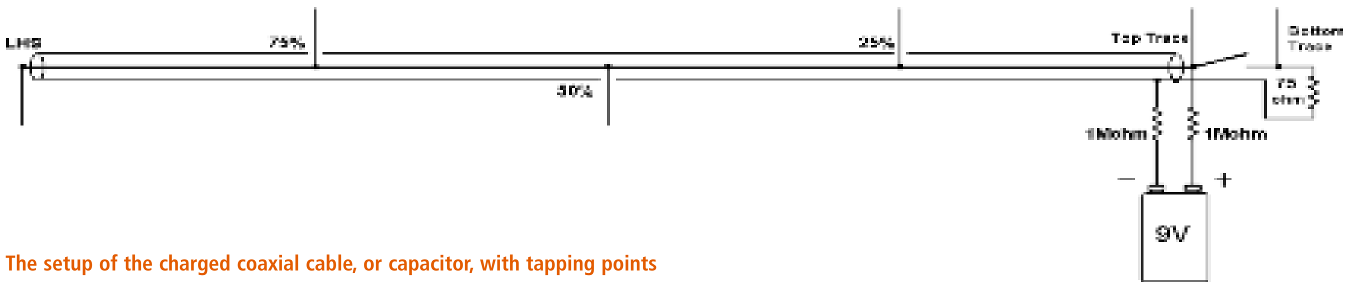
$\frac{1}{2}CV^2$

The two energies, one travelling to the right and the other to the left, have nothing to do with each other. Thus 8v, the V in the formula $\frac{1}{2}CV^2$, is not a proper measure of the total energy, which relates to the two energies, each of amplitude 4v. Thus, looking at the real “electric” fields, we end up with half the energy which we know is in the charged capacitor. The other half of the energy is made up of the two magnetic fields $\frac{1}{2}LI^2$. $4^2 + 4^2 + 4^2 + 4^2 = 8^2$.

Ivor Catt 13 March 2013

THE END OF THE ROAD?

DO EXPERIMENTAL RESULTS MEAN THE END OF THE ROAD FOR WHAT HAS BEEN TAUGHT TO 14-YEAR-OLDS THROUGHOUT THE WORLD FOR 150 YEARS, WHICH IS A "STEADY CHARGED CAPACITOR" HAS STATIC ELECTRIC FIELD BETWEEN THE TWO PLATES? BY **IVOR CATT**



The setup of the charged coaxial cable, or capacitor, with tapping points

A capacitor, made of 50 ohm coaxial cable, is slowly charged up to 8V from a voltage supply via a large resistor. It is then suddenly discharged by closure of a reed relay into a long 50-ohm cable. According to the Instruction Manual for the Type 109 pulse generator (GR) from Tektronix, the result is a double length, half-amplitude pulse.

On page 2, the manual states: "The output pulse duration is equal to twice the transit time of the charge line used, plus a small built-in charge time due to the lead length from the GR panel connectors to the mercury [reed relay] switch contact point."

"The transit time of the cable is defined as the time required for a signal to pass from one end of the line to the other. For a 10ns charge line then the duration of the output pulse would be 20ns. The pulse amplitude obtained will be approximately one-half the power source voltage..."

It seems that since I used it 49 years ago in 1964, nobody else has pondered the significance of the half-size double-length pulse. The final part of the energy must have waited for twice the delay time from end to end of the capacitor before exiting. In 1980 this led to me propounding: "This paradox, that when the switches are closed, energy current promptly rushes away from the path made available, is understandable if one postulates that a steady charged

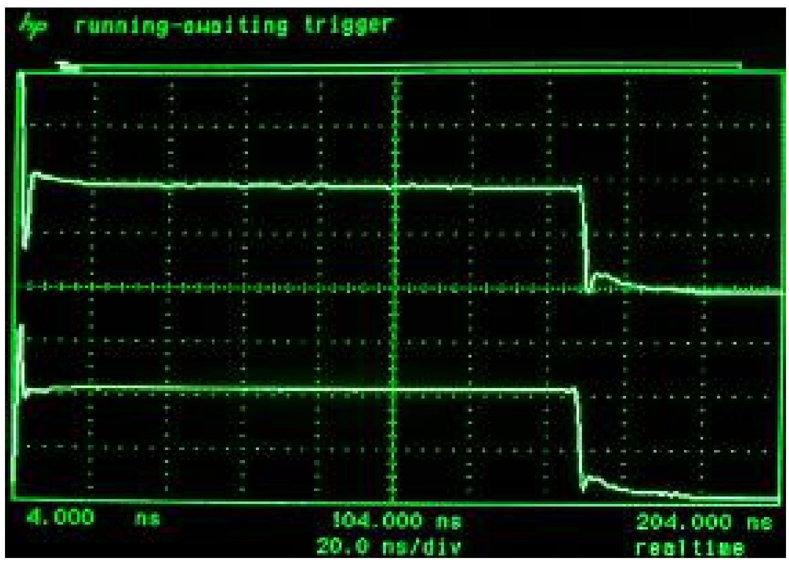


Figure 1: **Bottom Trace:** The bottom trace probe is across the 75Ω terminator used as a trigger. It shows a pulse of the half battery voltage (actually 8V after the 2 x 1MΩ resistors and the probe loading);
Top trace: Left-hand side of the reed switch. The trace immediately drops from 8V to 4V

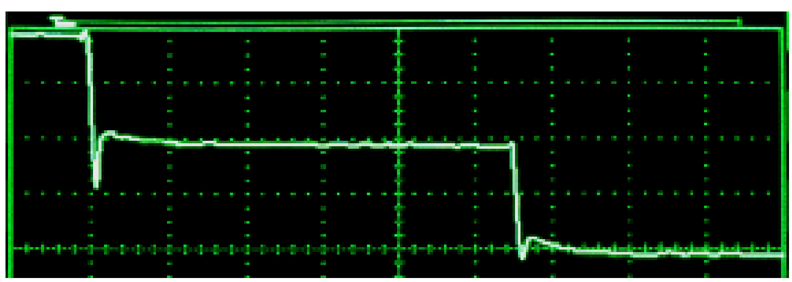


Figure 2: 25% to the left of the reed switch (4.5m)

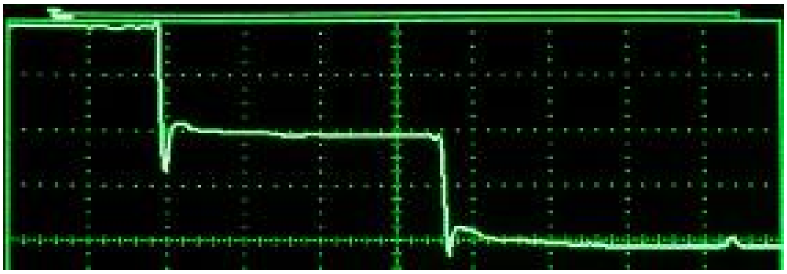


Figure 3: 50% to the left of the read switch

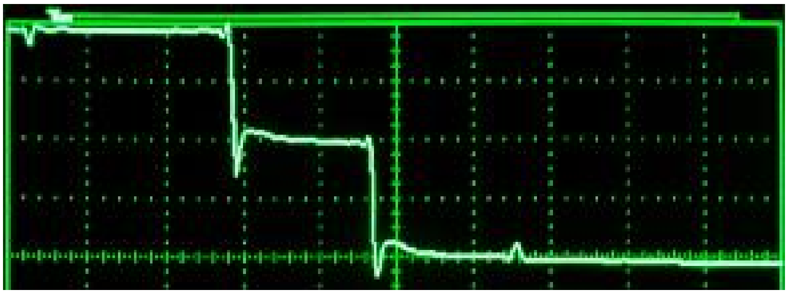


Figure 4: 75% to the left of the reed switch

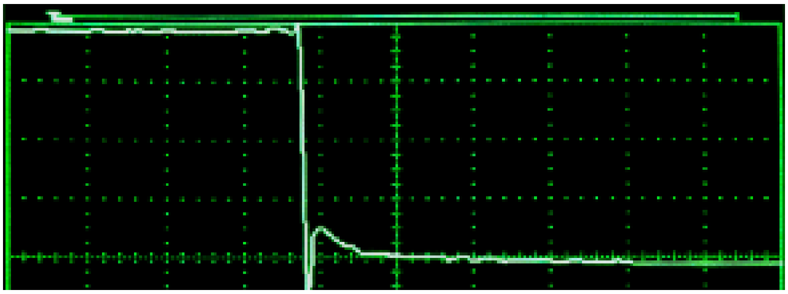


Figure 5: At extreme left of the unterminated end of the coax

capacitor is not steady at all; it contains energy current, half of it travelling to the right at the speed of light, and the other half travelling to the left at the speed of light.

Now it becomes obvious that when the switches are closed, the rightward-travelling energy current will exit first, immediately followed by the leftward-travelling energy current, after it has bounced off the open circuit at A.

We are driving toward the principle that Energy (current) E x H cannot stand still; it can only travel at the speed of light. Any apparently steady field is a combination of two energy currents travelling in opposite directions at the speed of light. E and H always travel together in fixed proportion Zo." – *"Death of Electric Current"*, Wireless World, December 1980, page 79.

An Historic Experiment

On 5 June 2009 I belatedly realised that we could do an historic experiment. It was to set up a Tek109 pulse generator with a 40ns charging line, but introduce monitor points every 10ns along the line into a sampling scope. We would then see the clean way in which the charged voltage, say 8V, drops to 4V at the appropriate moment when the first part of the output pulse has outputted to the right but the second part, travelling in the opposite direction is not present. That is, first of all we would see 8V and then for a period we would see 4V, then 0V.

The 'establishment' would have to resist the obvious conclusion, that before the reed relay was closed, half of the energy in the cable was already travelling to the right and the other half to the left. Nothing was ever stationary.

My colleague Forrest Bishop and I had bought four Tektronix 109 pulse generators, and matters had drifted for three years.

There were considerable problems in getting the necessary equipment together. Finally, after three frustrating years, Tony Wakefield of Melbourne succeeded, and we here present the results. Wakefield happened to have a newer type of oscilloscope that could register a one-shot with a response of 2ns, and as such he did not need the Tektronix pulse generator. Within a few days he had done the experiment and delivered his results.

> It seems that nobody else has pondered the significance of the half size double length pulse

We now have experimental proof that the so-called steady charged capacitor is not steady at all. Half the energy in a charged capacitor is always travelling from right to left at the speed of light, and the other half from left to right.

The Wakefield experiment uses a 75-ohm coax 18 meters long. The left-hand end is open circuit. The right-hand end is connected to a small, 1cm long, normally-open reed switch. On the far side of the reed switch is a 75-ohm termination resistor simulating an infinitely long coaxial cable. A handheld magnet is used to operate the switch.

The coax is charged from a 9V battery via 2 x 1 megohm resistors, close-coupled at the switch to centre and ground. The two resistors are used to isolate the relatively long battery wires from the coax. High value resistors are used to minimize any trickle charge after the switch is closed.

A 2-channel HP 54510B digital sampling scope set to 2V/div vertical and 20ns/div horizontal is used to capture

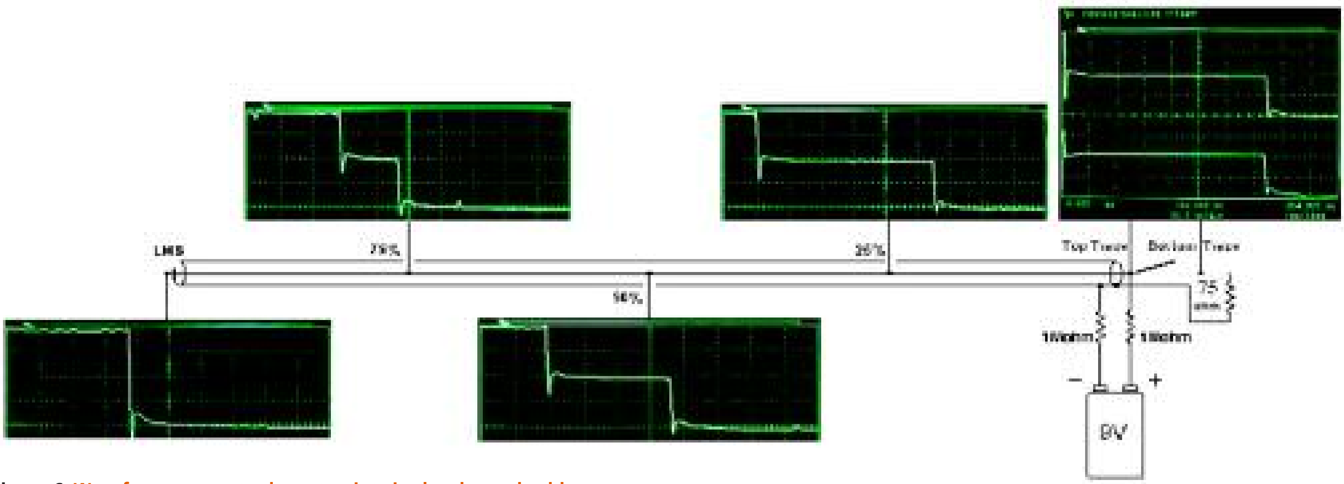


Figure 6: Waveforms seen at relevant points in the charged cable

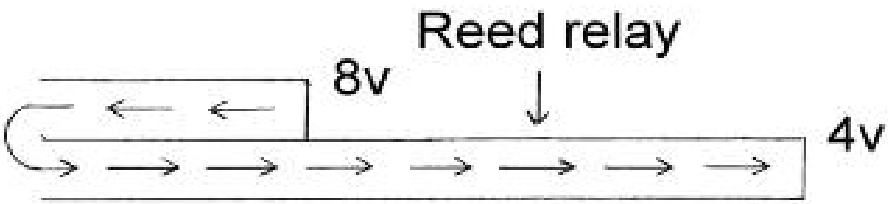


Figure 7: Snapshot of the cable when one quarter of the pulse has left the capacitor

five images:

1. The bottom trace probe is across the 75-ohm terminator used as a trigger. It shows a pulse half the battery's voltage (actually 8V after the 2 x 1 megaohm resistors and the probe loading).
   Top trace: left-hand side of the reed switch. The trace immediately drops from 8V to 4V.
2. 25% to the left of the reed switch (4.5m).
3. 50% to the left of the reed switch (9m).
4. 75% to the left of the reed switch (13.5m).
5. At the extreme left of the unterminated end of the coax.

A Change In Theory

In my article entitled *"Displacement Current"* in Wireless World in December 1978 I pointed out that when a battery charges a capacitor, the energy is introduced into the capacitor at the speed of light. Once inside the capacitor, there is no mechanism for the energy to slow down.

The change in theory for a charged capacitor from stationary electric field to two electromagnetic fields travelling at the speed of light is an introduction to my general theory, that there is no such thing as a stationary field, electric or magnetic. Not only in the case of a charged capacitor, but always, any apparently stationary electric or magnetic field is in fact the superposition of two E x H electromagnetic fields travelling in opposite directions. Occam's Razor supports this assertion. In the case of the charged capacitor, the two electromagnetic fields are equal and opposite. They cancel, so an instrument cannot detect them. This gives the impression that a charged capacitor only has electric field, although the energy delivered to it when charging is a TEM wave of E x H energy current. The delivered energy is conventionally said to have half its energy in the electric field and half in its magnetic field, travelling at the speed of light.

In Electronics World, January 2011, page 20, I again proved from first principles that such a TEM wave can only travel at the speed of light for the dielectric, $\pm 1/\sqrt{\mu\varepsilon}$. It cannot travel slower. In our case the only possible velocity remains c, because it should be well known that when two pulses travel through each other in a coaxial cable they do not slow down. Rather, I^2R losses disappear. ●

ONGOING DOUBTS

ALTHOUGH MY COLLEAGUE FORREST BISHOP ARGUES THAT SURELY SOMEONE ELSE WILL ALREADY HAVE THOUGHT OF TAPPING INTO THE CHARGED PIECE OF COAXIAL CABLE TO SEE WHAT HAPPENS DURING DISCHARGE, I DOUBT IT. After all, it was only after more than 40 years that the idea occurred to me. Also, it somewhat contradicts Forrest's other point, that long ago he realised the level of competence among those with accreditation in electromagnetic theory – professors and textbook writers – is far lower than I would have imagined until recently. They are lost in a cloud of dubious mathematics and early 20th century delusions including wave-particle dualism, also using Fourier to ignore anything other than sine waves, and so lack grasp of the physics of a TEM pulse.